

## §28. Two Dimensional Ion Temperature and Velocity Measurements by Use of Visible Light Tomography Technique

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For the past five years, we have been developing a new visible-light tomography system for two dimensional (2-D) measurements of ion temperature and velocity. In 2005, we developed, 1) a new reconstruction software for 2-D plasma velocity measurement and 2) a part of optical fiber system and optical lens system for this system. As for (1), we reconstructed the local 2-D plasma velocity profile from the measured line-integrated line spectrum with Doppler shift. The 2-D plasma velocity profile is composed of two components as shown in  $\mathbf{v} = \nabla \times \psi + \nabla \phi$ ------(1),

so that we obtain the following Radon transformation form:

$$R\{\zeta\}(u, \eta) = - \int_{-\infty}^u \mathbf{v}\{\theta\}(u', \eta) du' \text{-----}(2),$$

based on an assumption that our plasma is incompressible as  $\nabla \cdot \mathbf{v} = 0$ . We solved the equation (2) using the maximum entropy method. Figure 2 shows the 2-D velocity profiles (vectors plot) (a) and the 2-D vorticity  $\psi$  contours (b) for an assumed toroidal velocity profile of low aspect ratio toroid which was peaked at the magnetic axis. Artificially, 10% white noises (n=1 component) were added to the line-integrated signals of line spectrum. Figures 2 indicate that the assumed 2-D velocity profile was reconstructed successfully within the error of 20%. As for (2), we installed the initial set of optical fibers: 9 channels to complete the 1-D velocity measurement system in order to test one section of the 2-D measurement system. Figure 3 shows the measured radial velocity profile of two merging spheromaks with counter helicity. It indicates that the bipolar toroidal velocity by the counter helicity reconnection was reconstructed successfully using our 1-D velocity

measurement system.

### References

- [1] A.Balandin, Y.Ono, J Comp. Phys. 202, (2005), 52.

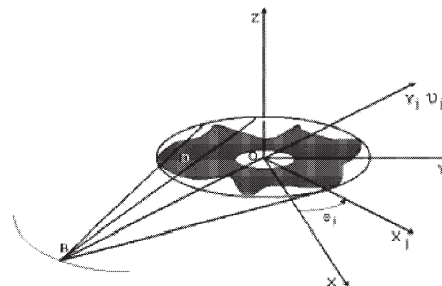


Fig. 1 Ion flow measurement by the vector tomography technology for visible light Doppler spectroscopy.

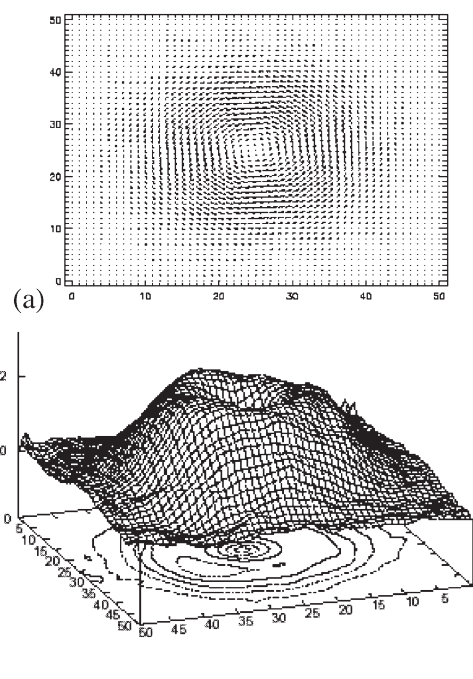


Fig. 2 2-D contours of plasma velocity (a) and vorticity (b) for a low aspect ratio toroid.

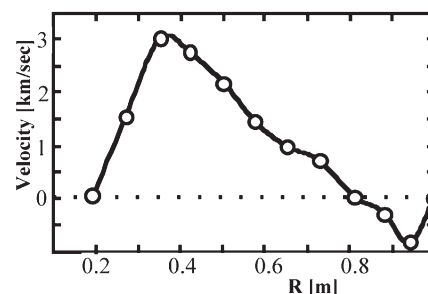


Fig. 3 Radial velocity profile of the two merging spheromaks with counter-helicity, which was measured by Doppler shift of ArII line.